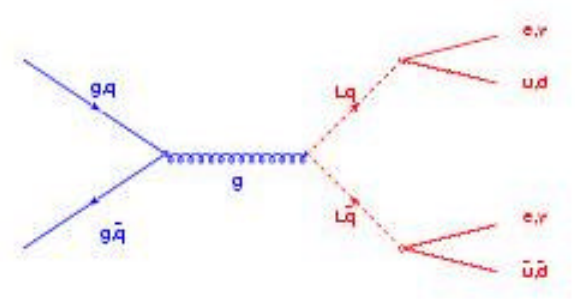
Combined limit for searches for 1st generation LQ

Simona Rolli (TUFTS)

-Blessing-

LQ at the TeVatron

- Production
  - qg → LQ + LQbar
  - gg → LQ + LQbar
  - qqbar → LQ + LQbar



- Decay
  - LQLQ → l^+l^-qq, $l^{\pm}nqq$, $nnqq$

β = Br(LQ->eq)

- Experimental signature:
  - High pt isolated leptons (and/or MET) + jets

cdf6338

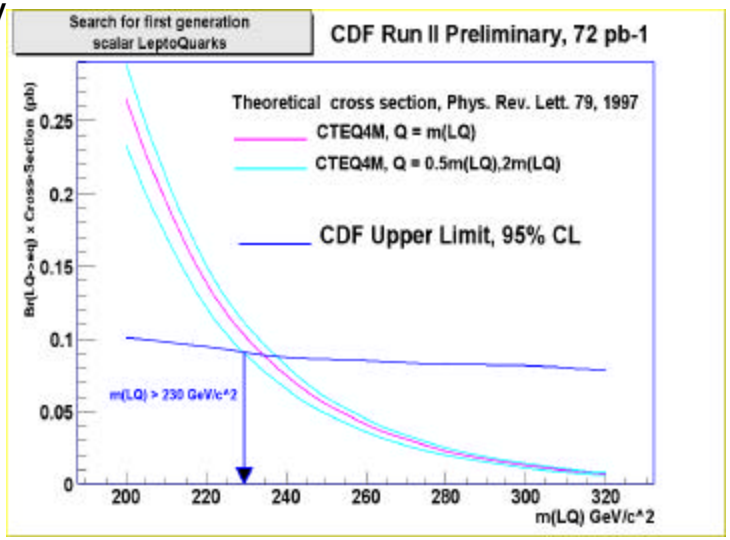
LQ search in eejj

Signature: 2 electrons and 2 jets

Analysis cuts

- 2 central electrons with E_T > 25 GeV
- 2 jets with $E_T(j1)$ > 30 and $E_T(j1)$ > 15 GeV
- removal of events with 76 < M_{ee} < 110 GeV
- $E_T(j1) + E_T(j2)$ > 85 GeV && $E_T(e1) + E_T(e2)$ > 85 GeV
- Ö(($E_T(j1) + E_T(j2)$)^2 + ($E_T(e1) + E_T(e2)$)^2) > 200 GeV

0 events seen after analysis cuts



Consistent with background expectation

cdf6436

LQ search in evjj

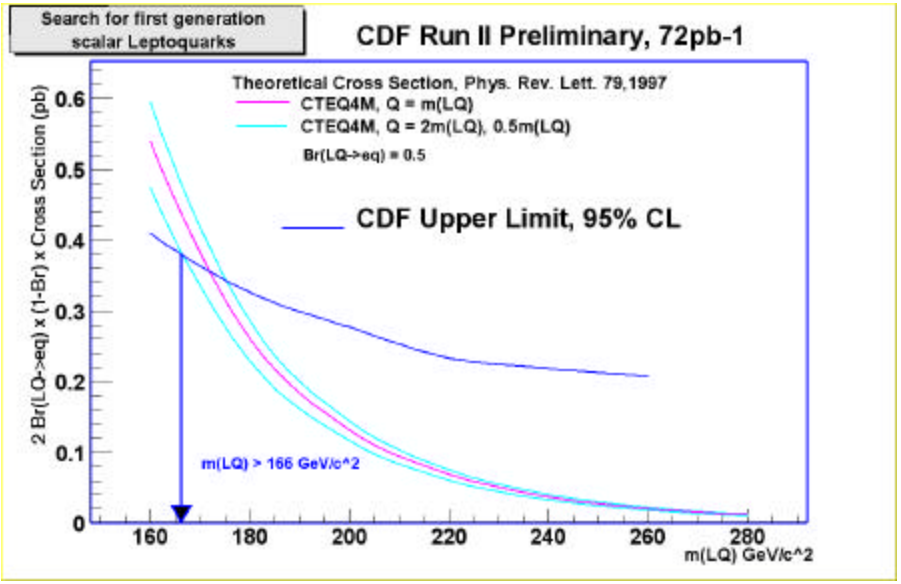
Signature: 1 electron, 2 jets and large MET

Analysis cuts

- 1central electrons with E_T > 25 GeV and MET > 35 GeV
- 2 jets with E_T > 30 GeV
- $\Delta\phi$ (MET-jet) > 10°
- $E_T(j1) + E_T(j2)$ > 80 GeV
- $M_T(e\text{-}\nu)$ > 120
- Met/$\sqrt{\Sigma E_T}$ > 4.5

2 events survive analysis cuts

Consistent with background expectation



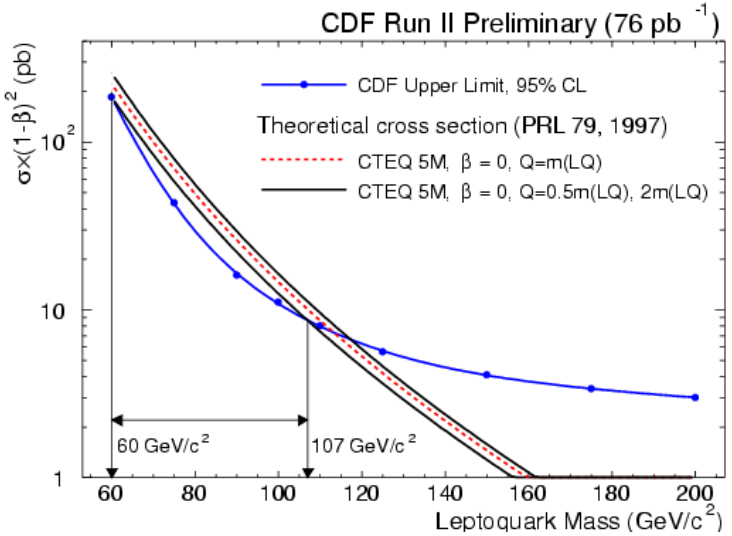
cdf6383

LQ search in ννjj

Signature: Large MET and 2 jets

Analysis cuts

- MET > 55 GeV
- 2 or 3 jets
  - E_T(jet1) > 40 GeV, E_T(jet2) > 25 GeV, E_T(jet3) > 7 GeV
  - $|\eta_{1/2}|<1$; $|\eta_3|<2.5$
  - No other jet with E_T > 7 GeV
- $100^o < \Delta\phi$ (MET-jet1/2) > 165°
- $80^o < \Delta\phi$ (jet1-jet2) > 165°
- $30^o < \min\Delta\phi$ (MET-jet2/3) > 135°
- Lepton veto
- 0.1 < Jet Em Fraction < 0.9
- min # of tracks in jet ≥ 4



42 events seen after analysis cuts

Consistent with background expectation

Combination method

- Bayesian approach: modification of bayes.f
- Joint likelihood formed from the product of the individual channels likelihood.
- For each mass we simulated 10K pseudo-experiments, smearing the calculated number of background events and the estimated number of signal events by their respective total uncertainties.
- The searches in the eejj and evjj channel use common criteria and sometime apply the same kind of requirements (for example on the tight electron identification) so the uncertainties in the acceptances have been considered completely correlated (which gives the most conservative limit).
- When calculating the limit combination including also the ννjj channel the uncertainties in the acceptances have been considered uncorrelated.A correlation factor of 0.5 has also been considered (no difference)

$$\sigma_{LIM} = N_{LIM}/(\varepsilon_{average} \times L)$$

$L = 72 pb^{-1}$

- $\varepsilon_{average} = (\beta^2\varepsilon(eejj) + 2\beta(1-\beta)\varepsilon(e\nu jj) + \beta^2\varepsilon(ee \text{ as } e\nu))$ for the 2 channels case and
- $\varepsilon_{average} = (\beta^2\varepsilon(eejj) + 2\beta(1-\beta)\varepsilon(e\nu jj) + (1-\beta)^2\varepsilon(\nu\nu jj) + \beta^2\varepsilon(ee \text{ as } e\nu))$ for the three channels case.

Acceptances I

eejj

mass (GeV/c^2)	acceptance
100	4.55363 +/- 0.341909 +/- 0.515905
140	17.773 +/- 0.606205 +/- 1.60647
160	29.0588 +/- 0.731018 +/- 2.53696
200	42.4134 +/- 0.8597 +/- 3.66693
220	45.2741 +/- 0.800441 +/- 3.86358
240	49.0665 +/- 0.818381 +/- 4.18398
260	50.3528 +/- 0.817434 +/- 4.29038
280	51.9668 +/- 0.81755 +/- 4.41945
300	52.6041 +/- 0.816628 +/- 4.4775
320	54.4296 +/- 0.821221 +/- 4.63773

Acceptances II

eνjj

mass (GeV/c^2)	acceptance
100	5.07256 +/- 0.327068 +/- 0.580013
120	9.4654 +/- 0.434233 +/- 0.947074
140	15.9426 +/- 0.535458 +/- 1.47083
160	21.7313 +/- 0.601313 +/- 1.93997
180	27.1751 +/- 0.648679 +/- 2.38167
200	31.5584 +/- 0.671279 +/- 2.73538
220	35.6339 +/- 0.685695 +/- 3.05863
240	38.2879 +/- 0.69566 +/- 3.2771
260	40.0651 +/- 0.697696 +/- 3.41961
280	42.2621 +/- 0.701753 +/- 3.59509

Systematics in ee/eν analysis

- Luminosity: 6%
- Acceptance
  - pdf 4.3% (from run I)
  - statistical error of MC 2.2%
  - jet energy scale (Level 3) 2.9 - 0.7 % (absolute uncertainty)
    - jets corrected for energy scale, time dependent and relative response
    - jet energy scaled of systematic uncertainty + 5% (energy scale + 5% data/MC adjustment); 0.08 to 0.01 systematic effect on signal acceptance
- Electron ID efficiency (Z')
  - statistical error of $Z \rightarrow e^+e^-$ sample: 0.8%
  - energy scale : 3.7%
- Event vertex cut : 0.5% (Willis)

Acceptances and systematics

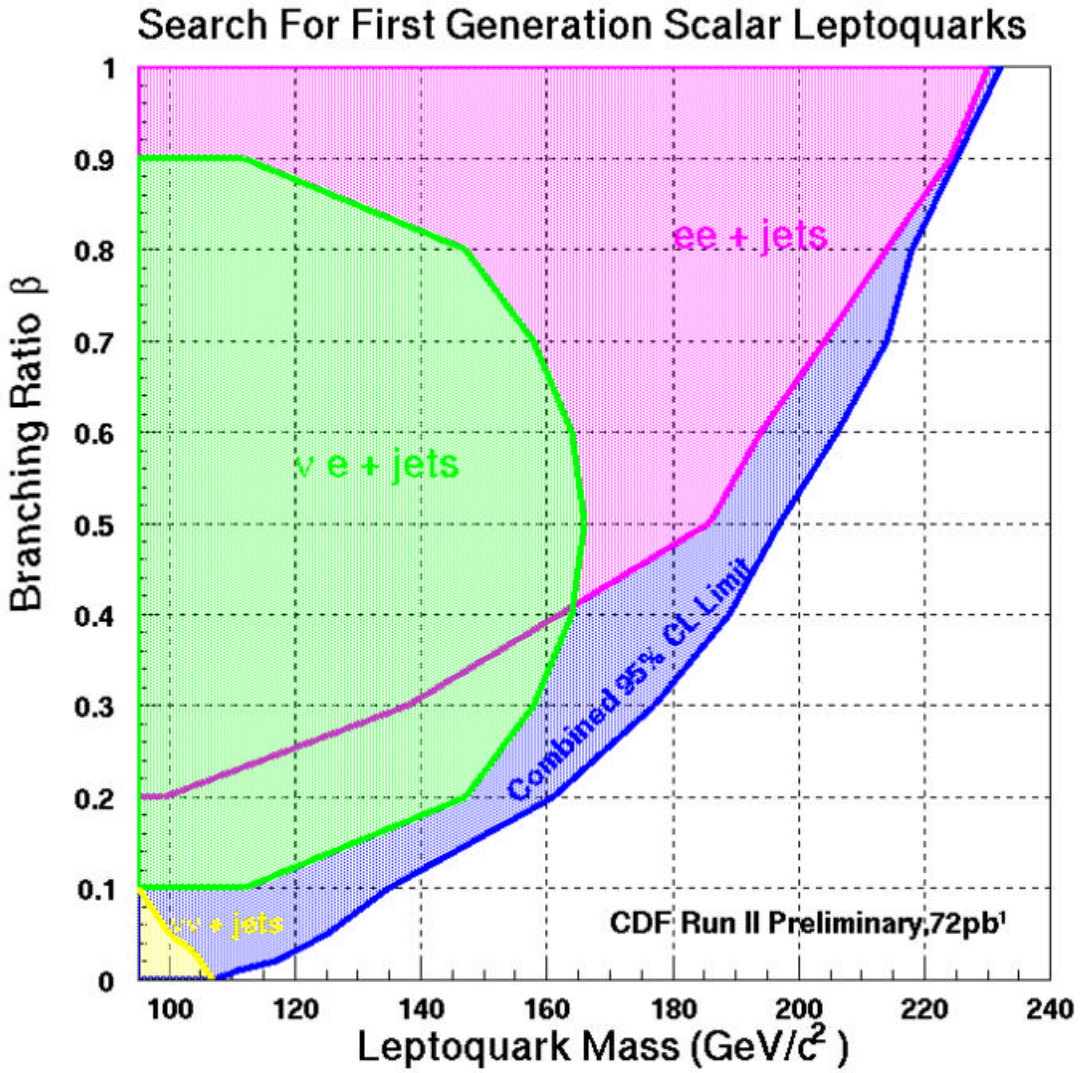
ννjj

LQ Mass (GeV/c^2)	Acceptance
60	0.0020
75	0.0085
90	0.0231
100	0.0334
110	0.0464
125	0.0662
150	0.0909
175	0.110
200	0.124

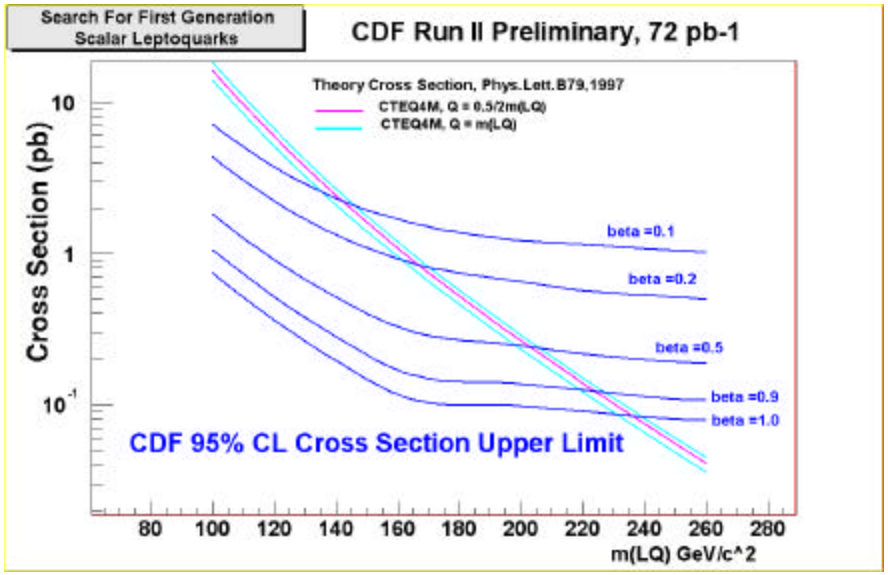
Systematic	Value
PDF	8%
ISR/FSR	10%
MC Statistics	3%
Luminosity	6%
Vertex Cut	0.5%
Trigger Efficiency	2%
Calorimeter Energy Scale	10%
Total	18%

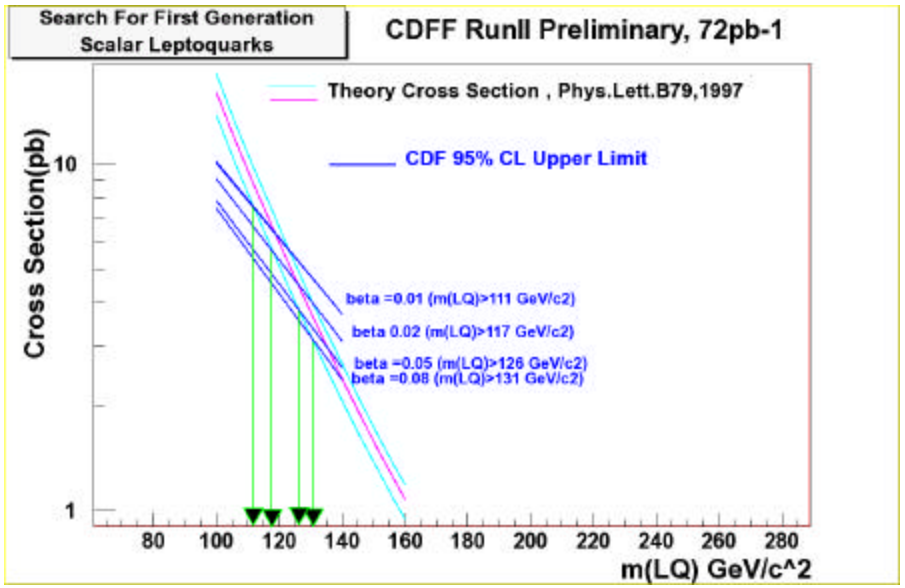
Result

111GeV/c^2 (β =0.01)
124GeV/c^2 (β =0.05)
135 GeV/c^2 (β =0.1)
161 GeV/c^2 (β =0.2)
197 GeV/c^2 (β =0.5)
232 GeV/c^2 (β =1.0)



Results


Search For First Generation
Scalar Leptoquarks
CDF Run II Preliminary, 72 pb-1
Theory Cross Section, Phys.Lett.B79,1997
CTEQ4M, Q = 0.5/2m(LQ)
CTEQ4M, Q = m(LQ)
beta =0.1
beta =0.2
beta =0.5
beta =0.9
beta =1.0
CDF 95% CL Cross Section Upper Limit
Cross Section (pb)
10
1
10^-1
80 100 120 140 160 180 200 220 240 260 280
m(LQ) GeV/c^2


Search For First Generation
Scalar Leptoquarks
CDFF RunII Preliminary, 72pb-1
Theory Cross Section , Phys.Lett.B79,1997
CDF 95% CL Upper Limit
beta =0.01 (m(LQ)>111 GeV/c2)
beta 0.02 (m(LQ)>117 GeV/c2)
beta =0.05 (m(LQ)>126 GeV/c2)
beta =0.08 (m(LQ)>131 GeV/c2)
Cross Section(pb)
10
1
80 100 120 140 160 180 200 220 240 260 280
m(LQ) GeV/c^2

cdf6571

Conclusions

- We have performed the combination of all the CDF searches for first generation scalar letpoquarks using Run II data.
- The results are combined using a procedure based on a Bayesian approach which takes into account the correlations in the systematic uncertainties.
- We set 95% CL lower limit for scalar first generation leptoquarks at

$111\ \mathrm{GeV}/c^2$ ($\beta = 0.01$),

$135\ \mathrm{GeV}/c^2$ ($\beta = 0.1$),

$161\ \mathrm{GeV}/c^2$ ($\beta = 0.2$),

$197\ \mathrm{GeV}/c^2$ ($\beta = 0.5$)

$232\ \mathrm{GeV}/c^2$ ($\beta = 1.0$).